NSRL Energy Loss Calculator

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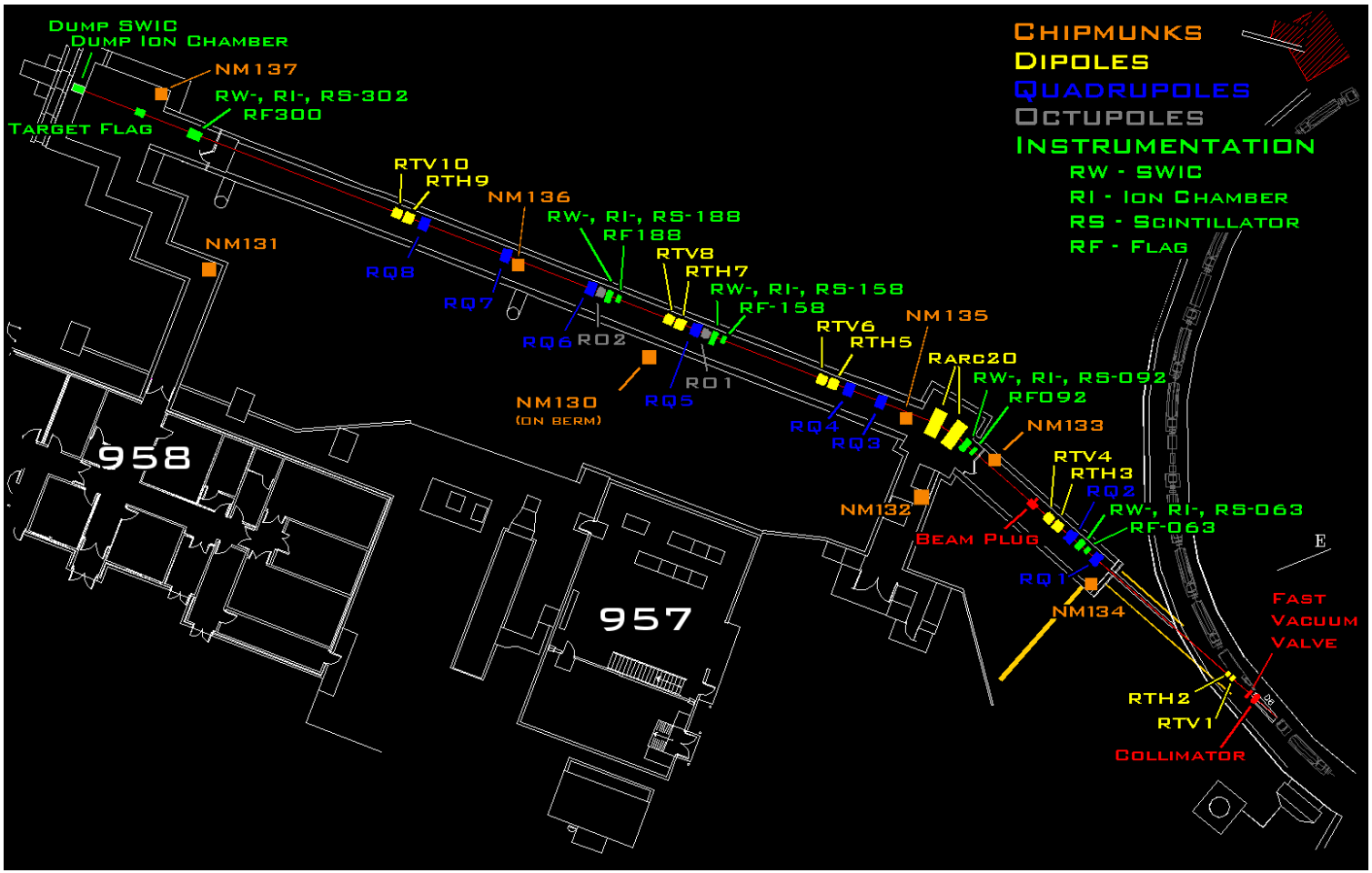
Why is there a need for an Energy Loss Calculator?

- Experimenters want a specific energy for their samples
- Beam has to travel trough objects to get to target and will lose energy
- Booster Extraction energy has to be higher than the desired Target energy.

NSRL Layout

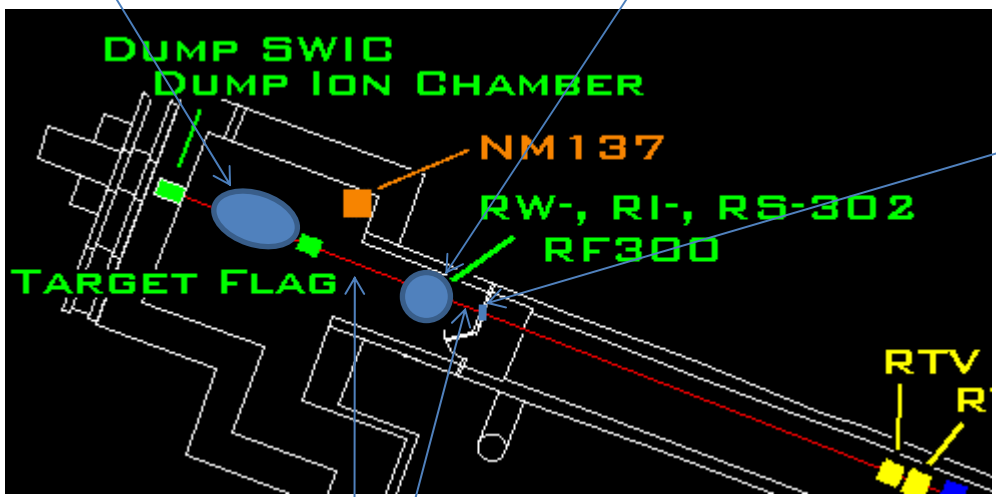


The Calculator is design for NSRL's beam line geometry. If the physical configuration of the beam line changes. The calculator must be updated also.

Fixed objects in the path of the beam

Bragg Curve Measurement Equipment

302 Instrumentation Package



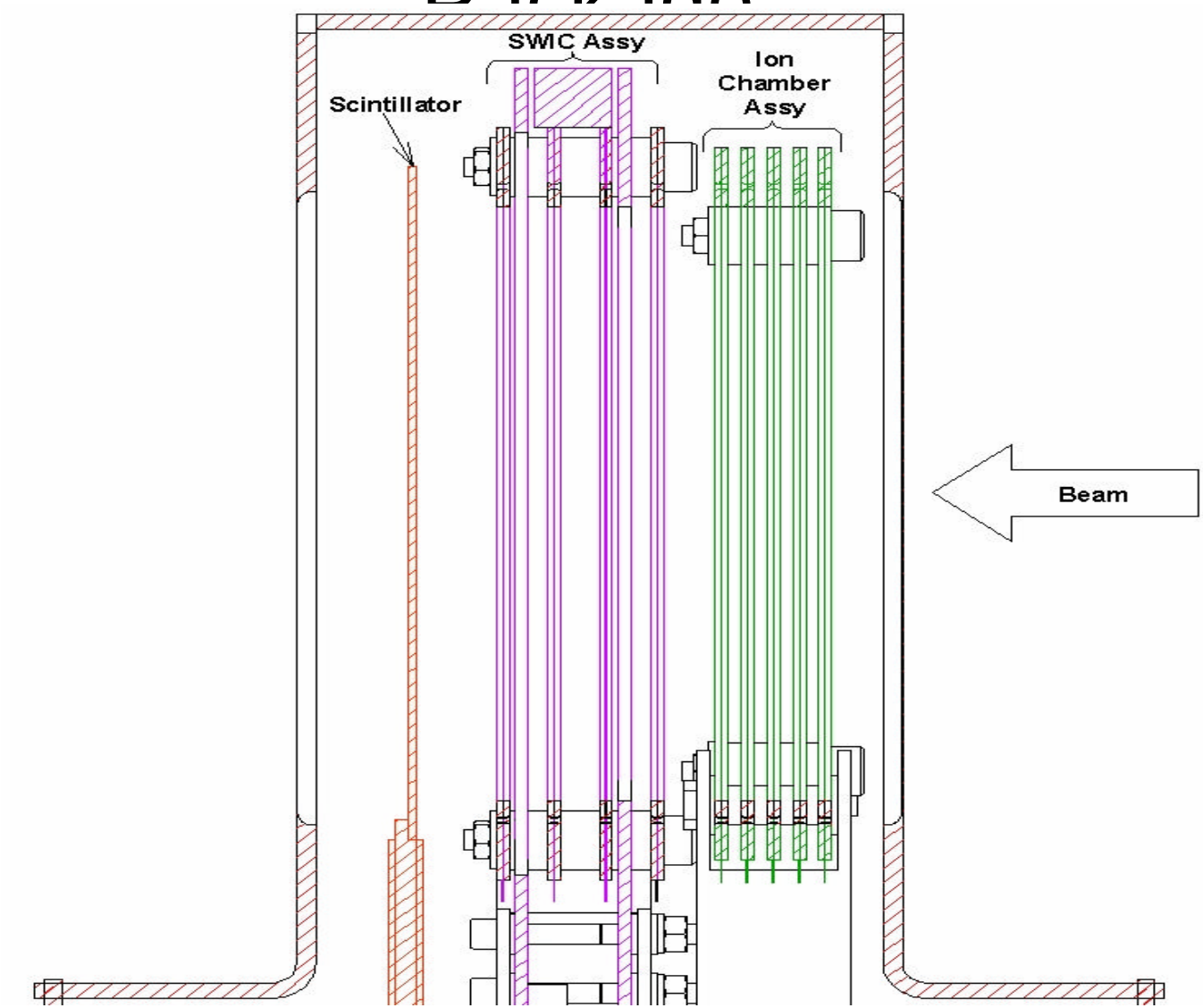
Aluminum Window

Air Gaps

Order of Intercept: Aluminum Window, Air Gap, 302 Inst Package, Air Gap, Bragg Curve Equipment

Picture of Equipment

Anatomy of an Instrumentation Package

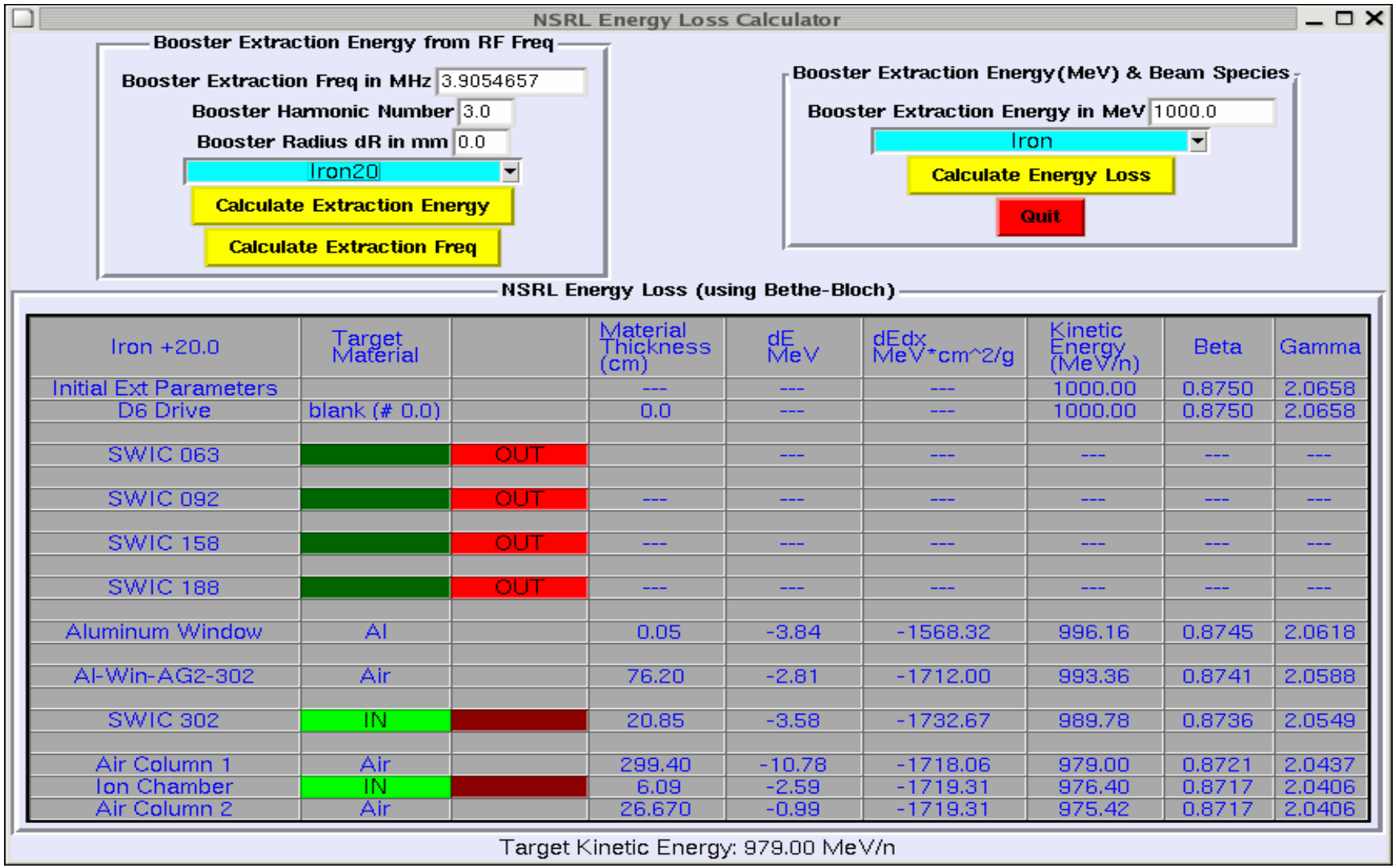


The Bethe-Bloch Equation

$$-\frac{dE}{dx} = K * z^2 \left(\frac{Z}{A}\right)\left(\frac{1}{\beta^2}\right)\left[\frac{1}{2} * \ln\left(\frac{2*\left(m_e c^2\right)*\beta^2 * \gamma^2 * T_{\max}}{I^2}\right) - \beta^2\right]$$

- The Constants
  - K = 0.3071 MeV, Rest Mass Energy of an Electron
- Terms dependent on Beam Parameters
  - z, Beta, Gamma, Kinetic Energy of Beam
- Terms dependent on Target Parameters
  - Z/A ratio, Mean Ionization Energy

NSRL Energy Loss Calculator Interface

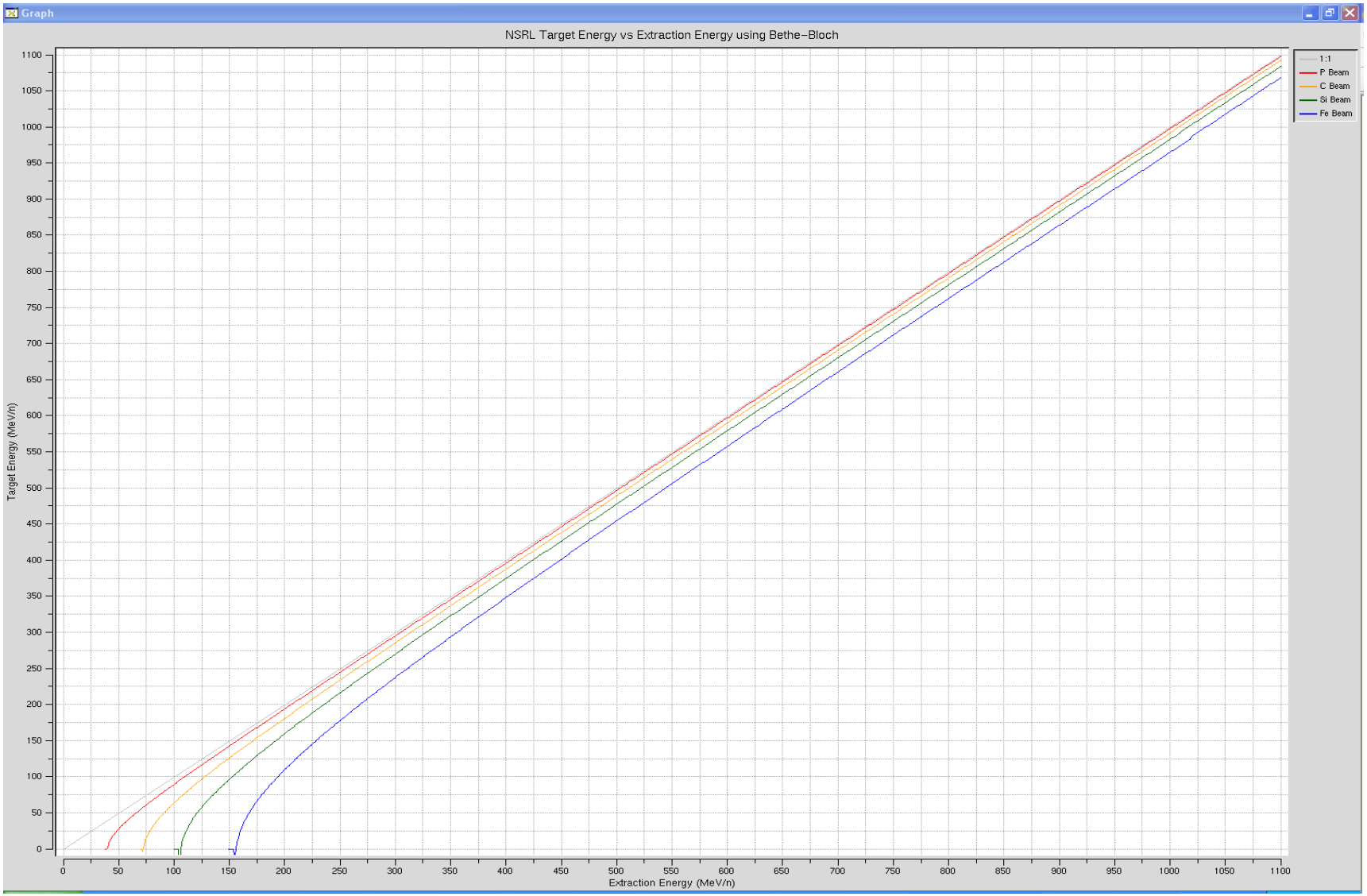


Iron +20.0	Target Material		Material Thickness (cm)	dE MeV	dEdx MeV*cm^2/g	Kinetic Energy (MeV/n)	Beta	Gamma
Initial Ext Parameters			---	---	---	1000.00	0.8750	2.0658
D6 Drive	blank (# 0.0)		0.0	---	---	1000.00	0.8750	2.0658
SWIC 063		OUT		---	---	---	---	---
SWIC 092		OUT	---	---	---	---	---	---
SWIC 158		OUT	---	---	---	---	---	---
SWIC 188		OUT	---	---	---	---	---	---
Aluminum Window	Al		0.05	-3.84	-1568.32	996.16	0.8745	2.0618
Al-Win-AG2-302	Air		76.20	-2.81	-1712.00	993.36	0.8741	2.0588
SWIC 302	IN		20.85	-3.58	-1732.67	989.78	0.8736	2.0549
Air Column 1	Air		299.40	-10.78	-1718.06	979.00	0.8721	2.0437
Ion Chamber	IN		6.09	-2.59	-1719.31	976.40	0.8717	2.0406
Air Column 2	Air		26.670	-0.99	-1719.31	975.42	0.8717	2.0406

How the Solar Particle Simulator implements the Energy Loss Calculator?

- Takes the desired target energy as the initial energy.
- Energy is run through the calculator.
- The predicted target energy is checked to see if it is within some tolerance.
- Depending on what side of the target energy, that number is either subtracted or added to the initial starting energy
- This is repeated until the energy is within the target energy tolerance

Predicted Curves



How compound elements are treated?

Kapton Composition		Weighting	Weighted	Weighted
Z	A	Value	Z	A
1	1.00794	0.026362	0.026362	0.026571314
6	12.00000	0.691133	4.146798	8.293596
7	14.00674	0.07327	0.51289	1.02627384
8	15.994	0.209235	1.67388	3.34650459
		effective	6.35993	12.69294574

CO2		Weighting	Weighted	Weighted
Z	A	Value	Z	A
6	12.00000	0.272916	1.637496	3.274992
8	15.994	0.727084	5.816672	11.6289815
		effective	7.454168	14.9039735

SiO2		Weighting	Weighted	Weighted
Z	A	Value	Z	A
8	15.994	0.532565	4.26052	8.51784461
14	28.0855	0.467435	6.54409	13.12814569
		effective	10.80461	21.6459903

Air		Weighting	Weighted	Weighted
Z	A	Value	Z	A
6	12.00000	0.000124	0.000744	0.001488
7	14.00674	0.755267	5.286869	10.5788285
8	15.99491	0.231781	1.854248	3.707316235
18	39.948	0.012827	0.230886	0.512412996
		effective	7.372747	14.800045730